Draft

Howard Street
Traffic Study
Bangor, Maine

Prepared for:
The City of Bangor
83 Harlow Street

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AMES A/E No. 06123-01

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Introduction

AMES A/E, Architects and Engineers, has been retained by the City of Bangor to conduct a traffic study to review a portion of the eastside of the City encompassing the area bounded by Maple Street, State Street, Howard Street, and Stillwater Avenue. This area of the City is predominantly residential in nature but includes the Fruit Street Elementary School and the William Cohen Middle School located centrally within this neighborhood. The study area is shown in Map 1.

With the continued growth of the commercial retail development within the Bangor Mall area directly to the north and Eastern Maine Medical Center to the south, both City officials and local residents are becoming concerned with the amount of traffic utilizing local streets within the neighborhood to access these major destinations.

Of particular concern is the amount of through traffic that appears to be utilizing Howard Street. This roadway provides a convenient and direct connection from State Street to Stillwater Avenue with a traffic signal located at the Stillwater Avenue/Howard Street intersection. Residents of Howard Street are not only troubled with what appears to be an increase in traffic volumes , but an increase in average speeds of motorists looking to use the street as a short-cut to get from State Street to Stillwater Avenue and vice versa . In depth discussions with City of Bangor officials and local residents have occurred to evaluate ways to reduce traffic volumes and speeds along Howard Street as well as consider access modifications to Howard Street itself, such as making portions of the street one way or dead ending the street. Any change of use or configuration to Howard Street will likely have a traffic impact on the other adjacent roadways such as Maple Street, Birch Street, and Fern Street that provide similar through connection from State Street to Stillwater Avenue.

The purpose of this study is to review the traffic volumes utilizing the fore mentioned roads within the neighborhood and determine if traffic volumes and speeds are creating unsafe and undesirable conditions, given the existing roadway and intersection geometry. This study provides recommendations for improvements in locations where deficiencies have been identified.

Roadway Descriptions and Classifications

The four roadways that are the primary focus of this study include Maple Street, Birch Street, Fern Street and Howard Street. These four streets provide a direct connection from State Street to Stillwater Avenue within the neighborhood and would likely be the most impacted by any alterations to Howard Street. All of these streets have a posted speed limit of 25 MPH.

Maple Street
Maple Street is a local roadway. The roadway width varies significantly from 26-foot average width between State Street and Garland Street to a 50 foot average width from Garland Street to Mount Hope Avenue. Immediately north of Garland Street the roadway width is 21 feet and then increases to 30 feet south of Stillwater Avenue. Sidewalk is provided on both sides of the street from State Street to Mount Hope Avenue. North of Mount Hope Avenue, sidewalk is provided on the east side only. Vehicle on-street parking is permitted on the west side from State Street to Mount Hope Avenue. Parking is allowed on the east side of the roadway from Garland Street to Stillwater Avenue.

Birch Street
Birch Street is a local roadway with a fairly uniform width of 25 to 26 feet from State Street to Howard Street. Sidewalk is provided on both sides of the street from State Street to Mount Hope Avenue. North of Mount Hope Avenue, sidewalk is provided on the west side of the road only. Vehicle on-street parking is permitted on the east side of the street only from State Street to Daytona Street.

Fern Street
Fern Street is a local roadway with a fairly wide cross section for its entire length with a width ranging from 38 to 42 feet from State Street to Stillwater Avenue. Sidewalk and on-street parking are provided on both sides of the street for its entire length. Two, four-way stop intersections exist on Fern Street and are located at the intersections of Fern Street/Garland Street and Fern Street/Mount Hope Avenue.

Howard Street
Howard Street is classified as a Major Collector Road by the Maine Department of Transportation (MeDOT). This street falls into the same roadway classification as Mount Hope Avenue, Garland Street and outbound Essex Street. As a Major Collector Road, Howard Street is eligible for federal funding with an 80 percent federal share, 15 percent City share and 5 percent State share.

The average width of Howard Street between State Street and Garland Street is 30 feet. North of Garland Street, Howard Street narrows to about 24 feet with further reduction to approximately 22 feet immediately south of Mount Hope Avenue. North of Mount Hope Avenue, Howard Street widens to about 39 feet.
Sidewalk is available on both sides of Howard Street from State Street to Garland Street and from Mount Hope Avenue to Stillwater Avenue. Between Garland Street and Mount Hope Avenue, Sidewalk is available on both sides of the street for approximately 550 feet north of Garland Street. The remaining section has sidewalk on the west side of Howard Street only.

On street parking is prohibited on Howard Street from State Street to Garland Street. Between Garland Street and Birch Street, on-street parking is allowed on both sides

of the street. North of Birch Street, on-street parking is prohibited. It was observed during our field visits to the study area, that on-street parking along Howard Street is not as prevalent as it is on the adjacent streets. This is most likely due to the fact that the homes along Howard Street typically having larger setbacks and longer driveways than the homes on Maple Street, Birch Street, and Fern Street.

Existing signage on both ends of Howard Street prohibit through trucks from utilizing the street.

Traffic Data

In order to have current traffic data for our study, AMES A/E placed Automatic Traffic Recorders (ATR's) on Maple Street, Birch Street, Fern Street, and Howard Street between Garland Street and Mount Hope Avenue. These counters recorded 24-hour traffic data from November 1, 2006 to November 6, 2006 (Howard Street and Fern Street) and from November 7, 2006 to November 13, 2006 (Birch Street and Maple Street). The data collected by these counters provides hourly, daily, and directional traffic volume data as well as vehicle speed data.

In reviewing MeDOT's 2005 Weekly Group Mean Factors within their Traffic Volume Counts 2005 Annual Report, traffic volumes in urban areas are slightly higher than average during the month of November. Because of this fact, we did not apply a seasonal adjustment to the collected traffic data to develop average annual daily traffic volumes (AADT). To determine the average weekday traffic volumes for the reviewed roadways, data collected on Wednesdays, Thursdays, and Fridays was utilized.

A summary of the collected data from the ATR counters is as follows:

Maple Street	
Average Weekday Traffic Volumes	1,258 Vehicles/Day
Average Travel Speed	26 MPH
85th Percentile Speed	31 MPH
Birch Street	
Average Weekday Traffic Volumes	845 Vehicles/Day
Average Travel Speed	27 MPH
85th Percentile Speed	35 MPH
Fern Street	
Average Weekday Traffic Volumes	1,981 Vehicles/Day
Average Travel Speed	29 MPH
85th Percentile Speed	35 MPH

Howard Street	
Average Daily Traffic (ADT) Volumes	3,504 Vehicles/Day
Average Travel Speed	28 MPH
85th Percentile Speed	32 MPH

As the above summary shows, Howard Street does experience higher daily traffic volumes than the other three reviewed streets. The higher volume along Howard Street can be expected however, based on our observations as well as this roadway being classified and utilized as a Major Collector Road.
The other classified Major Collector Roads within the study area include Mount Hope Avenue (5,280 Vehicles/Day -West of Howard Street) and Garland Street (3,140 Vehicles/Day – West of Birch Street).

The vehicle speeds on Howard Street however are very similar to the speeds experienced on Maple Street, Birch Street, and Fern Street. Although residents have expressed concern with the speeds on Howard Street being "above average" for the neighborhood, it may be that the reduced width of Howard Street at certain locations makes vehicles appear to be traveling at higher rates than they actually are.

In addition to the 24-hour traffic recorder data, AMES A/E conducted peak hour intersection turning movement counts at the following locations:

- Howard Street /Stillwater
- Howard Street/Mount Hope
- Howard Street/Garland Street
- Howard Street/State Street
- Fern Street/State Street
- Fern Street/Garland Street
- Fern Street/Mount Hope
- Fern Street/Stillwater
- Maple Street/State Street
- Maple Street/Stillwater Avenue
- Hancock/State Street

These counts were conducted on Wednesday, November 11, 2006, Thursday November 12, 2006, and Tuesday, November 21, 2006. The raw data as collected in the field is shown in Figure 1. Because the weekday evening peak hours at the intersections vary slightly at each location, the hour from 4:00 PM to 5:00 PM was selected as the period to be evaluated for this study. The traffic volumes at each intersection for this study period are shown in Figure 2.

Level of Service Analysis

In order to determine the existing operation of the streets and intersections within the study area, a Level of Service Analysis was completed for the weekday evening hour from 4:00 PM to 5:00 PM in accordance with the Highway Capacity Manual, 2000 Edition. Level of Service describes the ability of an intersection or roadway segment to accommodate the traffic volumes utilizing it. Letter values "A" through

"F" are assigned to conditions with "A" representing virtually no traffic delay and congestion and "F" representing long delays and heavy traffic congestion. The traffic volumes shown in Figure 2 included with this report were utilized for this analysis.

Levels of Service Criteria, as defined by the Manual, are shown in the following tables. Typically, Levels of Service "A" through "D" are considered acceptable during peak periods by the Maine Department of Transportation and most municipalities.

HCM Level of Service Criteria - Unsignalized Intersections	
Level of Service	Average Control Delay (Sec/Veh)
A	≤ 10
B	>10 and ≤ 15
C	>15 and ≤ 25
D	>25 and ≤ 35
E	>35 and ≤ 50
F	> 50.0

HCM Level of Service Criteria - Signalized Intersections	
Level of Service	Average Control Delay (Sec/Veh)
A	≤ 10
B	>10 and ≤ 20
C	>20 and ≤ 35
D	>35 and ≤ 55
E	>55 and ≤ 80
F	> 80.0

The results of our analysis at each reviewed intersection are summarized below. Computer printouts of the analysis are enclosed in the Appendix of this Study.

Intersection/Approach	Level of Service/Delay (Sec.) 2006 Weekday Evening Hour 4:00 PM to 5:00 PM
Howard Street/State Street	
State Street Eastbound	A/1.6
State Street Westbound Street	A/0.0
Howard Street	C/16.6
Average Intersection Delay	1.7
Howard Street/Garland	
Garland Street Eastbound	A/8.1
Garland Street Westbound	A/7.6
Howard Street Northbound	A/8.0
Howard Street Southbound	A/7.7
Average Intersection Delay	A/7.8
Howard Street/Mount Hope Ave.	
Mount Hope Eastbound	A/10.0
Mount Hope Westbound	B/12.0
Howard Street Northbound	A/9.6
Howard Street Southbound	A/9.3
Average Intersection Delay	B/10.8
Howard Street/Stillwater Avenue	
Howard Street	C/24.1
Stillwater Northbound	A/8.2
Stillwater Southbound	A/3.3
Average Intersection Delay	A/7.9

Intersection/Approach	Level of Service/Delay (Sec.) 2006 Weekday Evening Hour 4:00 PM to 5:00 PM
Fern Street/State Street	
State Street Eastbound	A/1.6
State Street Westbound	A/0.1
East Summer Northbound	C/21.0
Fern Street Southbound	C/16.5
Average Intersection Delay	2.7
Fern Street/Garland Street	
Garland Street Eastbound	A/8.1
Garland Street Westbound	A/8.5
Fern Street Northbound	A/8.2
Fern Street Southbound	A/7.9
Average Intersection Delay	A/8.2
Fern Street/Mount Hope Avenue	
Mount Hope Eastbound	A/9.2
Mount Hope Westbound	B/11.1
Fern Street Northbound	A/8.6
Fern Street Southbound	A/8.8
Average Intersection Delay	B/10.1
Fern Street/Stillwater Avenue	
Fern Street	C/19.3
Stillwater Avenue Northbound	A/0.0
Stillwater Avenue Southbound	A/0.6
Average Intersection Delay	1.4

Intersection/Approach	Level of Service/Delay (Sec.) 2006 Weekday Evening Hour 4:00 PM to 5:00 PM
Maple Street/State Street	
State Street Eastbound	A/1.1
State Street Westbound	A/0.0
Maple Street	C/15.3
Average Intersection Delay	1.3
Maple Street/Stillwater Avenue	
Maple Street	B/13.7
Stillwater Avenue Northbound	A/0.0
Stillwater Avenue Southbound	A/0.6
Average Intersection Delay	0.7
Hancock Street/State Street	
State Street Eastbound	B/13.2
State Street Westbound	A/5.7
Hancock Street	B/19.7
Otis Street	C/21.3
Average Intersection Delay	B/12.6

As the previous tables show, the reviewed intersections are currently operating at acceptable levels of service during the weekday evening hours. According to our analysis, the current traffic volumes utilizing the roadway network do not appear to be causing any significant delays or congestion during the reviewed time period.

Traffic Accidents

In order to complete a review of the accident occurrences and patterns within the study area, vehicle crash data was obtained from the Maine Department of Transportation Bureau of Maintenance and Operation for the most recent three-year period of available recorded data. The crash data provided from the Department included the three-year period spanning from 2003 to 2005. When reviewing vehicle crash data, the Maine Department of Transportation (MeDOT) evaluates not only the number of accidents at a given location, but the Critical Rate Factor for each location. Critical Rate Factor compares the number of crashes at a studied location with the

statewide average number of crashes at intersections or roadway segments with similar roadway characteristics. If the Critical Rate Factor is above 1.0, the location experiences a higher than average number of accidents. If a location experiences more than eight accidents in a three-year period and has a Critical Rate Factor greater than 1.0, the location is classified as a high crash location by MeDOT and should be reviewed to look for ways to improve driver safety at that location.

The crash data for the major intersections and roadway segments within the study area are summarized below and include the streets bounded by Maple Street, State Street, Stillwater Avenue, and Howard Street. The intersections and roadway segments that are classified as High Crash Locations (HCL's) have been highlighted in the table.

Accident Data (Intersections)
Within Study Area

MeDOT Node No.	Intersection		No. of Accidents	Critical Rate Factor
	Main Road	Side Road		
7237	State Street	Maple Street	3	0.49
7238	State Street	Wingate Court	1	0.17
7239	State Street	Birch Street	9	1.40
7240	State Street	Fern Street	3	0.49
7241	State Street	Pearl Street	1	0.17
7242	State Street	Fruit Street	2	0.22
7243	State Street	Hancock Street	28	1.14
7244	State Street	Hospital Entrance	6	0.30
7245	State Street	Howard Street	10	1.38
5212	Garland Street	Maple Street	1	0.39
4636	Garland Street	Birch Street	0	0.00
5209	Garland Street	Fern Street	0	0.00
4546	Garland Street	Pearl Street	1	0.49
5208	Garland Street	Fruit Street	0	0.00
4544	Garland Street	Otis Street	0	0.00
5203	Garland Street	Howard Street	3	1.65
5211	Mount Hope Avenue	Maple Street	4	1.38
4579	Mount Hope Avenue	Birch Street	0	0.00
5207	Mount Hope Avenue	Fern Street	15	4.32

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Accident Data (Intersections) Within Study Area

MeDOT Node No.	Intersection		No. of Accidents	Critical Rate Factor
	Main Road	Side Road		
4547	Mount Hope Avenue	Pearl Street	0	0.00
5206	Mount Hope Avenue	Fruit Street	1	0.36
5204	Mount Hope Avenue	Howard Street	10	2.63
4577	Stillwater Avenue	Maple Street	1	0.26
5210	Stillwater Avenue	Fern Street	3	0.59
4573	Stillwater Avenue	Howard Street	4	0.64
4571	Howard Street	Yale Street	0	0.00
5205	Howard Street	Juniper Street	0	0.00
4575	Howard Street	Juniper Street	2	1.46
4574	Howard Street	Birch Street	1	0.57
4552	Birch Street	Fern Street	0	0.00
4551	Birch Street	Pearl Street	0	0.00

Accident Data (Roadway Segments) Within Study Area

Segment			No. of Accidents	Critical Rate Factor
Road	From	To		
Stillwater	Maple	Fern	5	0.83
Stillwater	Fern	Howard	3	0.40
State	Maple	Merrimac	2	0.00
State	Merrimac	Wingate	0	0.00
State	Wingate	Birch	0	0.00
State	Birch	Fern	1	0.20
State	Fern	Pearl	1	0.24
State	Pearl	Fruit	2	0.61
State	Spruce	Fruit	0	0.00
State	Spruce	Hancock	1	0.42
State	Hancock	Ent. To EMMC	1	0.12
State	Ent. To EMMC	Howard	1	0.12
Maple	Stillwater	Mt. Hope	1	0.35
Maple	Mt. Hope	Garland	1	0.21
Maple	Garland	State	1	0.22
Fern	Birch	Stillwater	0	0.00
Fern	Birch	Juniper	0	0.00

Segment			No. of Accidents	Critical Rate Factor
Road	From	To		
Fern	Juniper	Daytona	0	0.00
Fern	Daytona	Mt. Hope	1	0.34
Fern	Mt. Hope	Garland	2	0.37
Fern	Garland	State	2	0.83
Howard	Stillwater	Birch	0	0.00
Howard	Birch	Juniper	1	0.91
Howard	Juniper	Juniper	1	0.36
Howard	Yale	Juniper	1	0.53
Howard	Yale	Mt. Hope	0	0.00
Howard	Angela St.	Mt. Hope	0	0.00
Howard	Angela St.	Garland	0	0.00
Howard	Garland	State	0	0.65
Birch	Pearl	Howard	0	0.00
Birch	Pearl	Fern	0	0.00
Birch	Fern	Daytona	0	0.00
Birch	Daytona	Mt. Hope	0	0.00
Birch	Mt. Hope	Garland	0	0.00
Birch	Garland	State	2	0.76
Pearl	Juniper	Birch	1	1.00
Pearl	Hemlock	Juniper	0	0.00
Pearl	Yale	Hemlock	0	0.00
Pearl	Mt. Hope	Yale	0	0.00
Pearl	Garland	Mt. Hope	1	0.73
Pearl	Garland	State	1	0.61
Mt. Hope	Birch	Maple	0	0.00
Mt. Hope	Birch	Fern	0	0.00
Mt. Hope	Pearl	Fern	0	0.00
Mt. Hope	Pearl	Fruit	0	0.00
Mt. Hope	Howard	Fruit	1	0.16
Garland	Birch	Maple	0	0.00
Garland	Birch	Fern	0	0.00
Garland	Pearl	Fern	0	0.00
Garland	Pearl	Fruit	0	0.00
Garland	Otis	Fruit	0	0.00
Garland	Otis	Howard	1	0.37
Fruit	Mt. Hope	Garland	0	0.00
Fruit	Garland	State	0	0.00
Otis	Garland	Otis (end)	0	0.00
Otis	Garland	State	2	0.65

As the previous tables show, none of the reviewed roadway segments have experienced more than eight accidents in the three-year period and have a Critical Rate Factor greater than 1.0. Five intersection locations however, are classified as HCL's, by definition.

The Bangor police reports for these five locations have been reviewed as a part of this study and are summarized as follows:

Howard Street/State Street Intersection
At the Howard Street/State Street intersection, 10 accidents were reported during the three-year period from 2003 to 2005. Eight of these accidents were rear-end types with the majority (6) being vehicles on State Street traveling eastbound, rear-ending a motorist making a left onto Howard Street. The two remaining accidents involved driver inexperience and icy road conditions.

At this location, we recommend the City of Bangor should look to address these accident issues by providing either improved delineation and signage or by limiting access to right-in/right-out only for Howard Street at this intersection.

Howard Street/Mount Hope Avenue
Ten crashes occurred at the intersection of Howard Street and Mount Hope Avenue during the reviewed three year period. All of these crashes were angular crashes due to one motorist failing to yield the right-of-way at the stop sign on Howard Street. In 2005, the City installed a four-way stop at this location including a red flashing light to address the accident levels at this intersection. Of the crash data provided, only one accident occurred in 2005 after the four-way stop was installed. This improvement appears to be appropriate for the reviewed accident conditions. Future monitoring of the accident rates at this intersection should continue by the City to determine if the four-way stop control has been a successful counter measure.

Mount Hope Avenue/Fern Street
The intersection of Howard Street and Fern Street experienced fifteen accidents during the three-year period. Similar to the Howard Street/Mount Hope Avenue intersection, all of the accidents were angle crashes due to motorists failing to yield at the stop sign on Fern Street. This intersection was similarly modified to a four-way stop with flasher light in 2005. This safety measure appears to be appropriate based on the reviewed accident police reports. Accident information should continue to be monitored at this location to determine the effectiveness of the four-way stop.

Birch Street/State Street
Nine crashes occurred at the Birch Street/State Street intersection from 2003 to 2005. Eight of these accidents were right angle crashes due to motorists on Birch Street not yielding the right of way to State Street Traffic. The remaining accident was

a sideswipe resulting from improper passing on State Street. It is our recommendation that the City of Bangor review the intersection sight distance at this intersection to determine if obstructions along State Street (i.e. parked cars, signs, or plantings) are reducing the visibility of motorists on Birch Street trying to enter onto State Street.

Hancock Street/Otis Street/State Street
The signalized intersection of Hancock Street/State Street/Otis Street experienced 28 crashes during the three-year period from 2003 to 2005. Thirteen of these accidents were of the rear end type with the majority occurring at the Hancock street right turn lane approach to eastbound State Street. Eight accidents involved left turning motorists failing to yield to through motorists. Five accidents were right-angle crashes due to motorists disregarding the red display of the signal. One accident was a side swipe and the remaining was a right turning motorists striking a pedestrian in the crosswalk.

Except for the westbound left turn lane from State Street onto Hancock Street, all of the other left turning movements operate under permitted left turning phasing at this intersection. This mode of operation requires left turning movements to yield to the through movements at the signal. The westbound left operates under protected/permitted signal operation where a left turn receives a green arrow signal display and then a green ball signal display. Under this operation, lefts during the green arrow display can turn without yielding to the through movements. During the green ball display, lefts must wait for a gap in the opposing through movement to complete their maneuver.

With the large number of left turns from State Street onto Hancock Street (510 vehicles during the weekday evening peak hour) the City may wish to look into extending the protected phase portion of the traffic signal timing for this movement. With future signal upgrades, the City should also provide a signal display for the right turning movements out of Hancock Street. This will help eliminate some of the driver confusion for this movement and reduce the number of rear-end crashes for this approach.

Traffic Calming Measures

Although our review of the existing traffic volumes/patterns and accident frequency do not show serious deficiencies within the study area that are not already being addressed, the City may wish to find ways to reduce the traffic volumes and vehicle speeds utilizing Howard Street as a cut-through roadway especially with the additional future growth being proposed within the immediate area of this East-Side Neighborhood.

The City of Bangor currently has two resident-initiated proposals in front of them to address the traffic on Howard Street.

The first of these proposals would be to make Howard Street one-way in the southbound direction from Mount Hope Avenue to Garland Street. Although this alternative would reduce traffic volumes by eliminating approximately 156 vehicles in the northbound direction during the evening peak hour, we believe that vehicle speeds would significantly increase in the southbound direction due to the increased travel way for the single lane and the elimination of traffic in the opposing direction. The northbound Howard Street traffic would likely utilize the adjacent roadways to access Mount Hope Avenue and Stillwater Avenue increasing traffic volumes on those streets.

The second of these proposals is to eliminate the continuity of Howard Street between Garland Street and Mount Hope Avenue by providing a double dead end to be located in the vicinity of Angela Street. It has been suggested that this dead end would be accomplished by providing a concrete median barrier across Howard Street and providing a by-pass to the side of the barrier for emergency vehicles only. Although this alternative would reduce through traffic, we believe a concrete barrier would pose a significant safety hazard to motorists. In addition, if access to the other side of Howard Street is available, it is probable that residents and other knowing motorists would make use of that connection thereby compromising the emergency viability of it.

If Howard Street is to be "dead ended", a proper termination should be developed that removes a portion of the pavement and provides proper areas to turn around. In reviewing the origin of the traffic volumes on Howard Street between Garland Street and Mount Hope Avenue, almost half (48%) of the motorists utilizing Howard Street are coming from Garland Street and Mount Hope Avenue. Approximately 210 vehicles during the evening peak hour would be required to use an alternative route if Howard Street is discontinued. With Howard Street being an important corridor within the neighborhood itself providing access to the hospital and connecting to the neighborhood schools, this alternative would not provide an overall positive benefit to the neighborhood in our opinion.

We do believe that there are some alternative traffic calming measures that would be appropriate along Howard Street that would result in the reduction of cut through traffic, motorists' speeds, and traffic volumes while maintaining access to Howard Street for use by the local residents.

As a safety improvement to address the high accident rate at the State Street and Howard Street intersection, we previously recommended providing right turn in and right turn out access only for Howard Street at this location. This safety measure provides a dual benefit by eliminating the large left turn volume (96 vehicles 4:00-5:00 PM) into Howard Street from State Street. A large portion of these 96 vehicles

are likely originating east of Hancock Street (EMMC) and would remain on State Street to access Hogan Road and Stillwater Avenue.

With approximately 2,000 feet of straight roadway on Howard Street between Garland Street and Mount Hope Avenue, measures should be placed to keep motorists from achieving unsafe speeds. I.T.E.'s Traffic Calming, State of the Practice list several measures for reducing speeds within residential neighborhoods including, speed humps, raised pavement, raised pedestrian crossings, curvilinear roadway alignment, central islands, and lateral shifts.

Of the several alternatives available, two measures seemed most appropriate for use along Howard Street due to the narrow right of way constraints. The Angela Street location lends itself to use of a small island or lateral shift to reduce vehicle speeds. A small landscaped island could be developed at this location where motorists would have to reduce their speeds to navigate around the island.

Approximately 550 feet north of Garland Street, the sidewalk ends on the east side of Howard Street. At this location, a raised pedestrian crosswalk could be provided as a measure not only to reduce vehicle speeds but to clearly delineate a crossing location for pedestrians to access the sidewalk on the west side of Howard Street.

With these measures to reduce vehicle speeds along Howard Street in place, this section of roadway will become less convenient for through traffic thus resulting in a decrease in through traffic use.

These improvements will keep Howard Street available for neighborhood and emergency use while making it less attractive for through motorists wishing to use it as a short-cut. The implementation of traffic calming measures is often a substantial process in itself, inclusive of numerous neighborhood meetings and involvement.

Conclusions and Recommendations

The following is a summary of the findings, conclusions, and recommendations determined within the Howard Street Traffic Study.

Based on the automatic traffic recorder data collected for the study, the average daily traffic volume along Howard Street is 3,504 vehicles/day. This value is higher than the traffic observed on Maple Street (1,258 vehicles/day), Birch Street (845 vehicles/day), and Fern Street (1,981 vehicles/day).

Although traffic volumes along Howard Street are higher than on the adjacent reviewed roadways, the average speed on Howard Street was recorded as 28 MPH which is very similar to the recorded speeds of the adjacent through streets.

Weekday evening peak hour intersection turning movement counts were conducted at several intersections within the study area. This data was used to complete a Level of Service analysis at each reviewed intersection. This analysis showed that all of the intersections evaluated were operating at acceptable levels of service during the weekday evening hour from 4:00 PM to 5:00 PM. None of the reviewed intersections appeared to experience excessive delays or lengthy vehicle queuing.

The intersection turning movement counts showed that 48 percent of the traffic utilizing Howard Street between Garland Street and Mount Hope Avenue originate from these two streets during the weekday evening peak hours.

A review of vehicle crash data provided by the Maine Department of Transportation for the three year period of 2003 to 2005 shows that five intersections within the study area are classified as High Crash Locations (HCL'S). These locations include Hancock Street/State Street, Birch Street/State Street, Howard Street/State Street, Howard Street/Mount Hope Avenue, and Fern Street/Mount Hope Avenue.

In 2005, the intersections of Howard Street/Mount Hope Avenue, and Fern Street/Mount Hope Avenue were modified to four-way stop control intersections with flashers. This modification is appropriate to address the accident rate at these locations. The City of Bangor should review future accident data to determine if these improvements have decreased the accident rates at these two locations.

At the intersection of Hancock Street/State Street, the City should increase the length of the protected left turn phase for vehicles turning left from State Street onto Hancock Street. With future signal upgrades, the use of protected left turn phasing should be considered as well as providing a visible signal display for the heavy right turning movement out of Hancock Street.

It is recommended that at the intersection of Birch Street/State Street, the City review sight lines to determine if roadside obstructions are impacting the visibility of motorists exiting from Birch Street onto State Street.

At the intersection of State Street/Howard Street, better delineation and signage should be provided for vehicles making a left onto Howard Street from State Street or eliminate this move completely by making Howard Street operate as a right turn in and right turn out only. Limiting Howard Street to right in/right out only would reduce the number of vehicle utilizing Howard Street.

With the number of motorists utilizing Howard Street, some measures to reduce vehicle speeds and discourage cut through traffic should be implemented between Garland Street and Mount Hope Avenue. Angela Street off of Howard Street provides an opportune location to introduce a small landscaped island that would create a

lateral shift in Howard Street forcing motorists to reduce speeds to negotiate through the shift in roadway alignment.

Approximately 550 feet north of Garland Street, the termination of the paved sidewalk on the east side of Howard Street provides another location where a traffic calming measure can serve dual purposes. At this location a raised pedestrian crosswalk is recommended to be installed to not only reduce speeds of motorists but also to provide permanent delineation for pedestrians wishing to access the sidewalk on the west side of Howard Street.

With these discussed improvements installed, it is our opinion that through traffic volumes and vehicle speeds along Howard Street can be reduced while still maintaining Howard Street for neighborhood and emergency traffic use.